KEITHLEY

# Model 236/237/238
## SOURCE MEASURE UNITS

QUICK REFERENCE GUIDE

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# INTRODUCTION

This quick reference guide contains descriptions of various features and information concerning the operation of the Model 236/237/238.

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# SAFETY WARNINGS

The following safety warnings should be observed before using Model 236/237/238 Source Measure Units.

The Model 236/237/238 Source Measure Unit is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury.

Exercise cautions when a shock hazard is present. Lethal voltages may be present on the test fixture or the Source Measure Unit connector jacks. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS or 42.4V peak are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the Source Measure Unit, test fixture, test cables or any other instruments while power is applied to the circuit under test. Turn off all power and discharge any capacitors before connecting or disconnecting cables or jumpers. Also, keep the test fixture lid closed while power is applied to the device under test. Safe operation requires the use of the lid interlock.

Do not touch any object which could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands

while standing on a dry, insulated surface capable of withstanding the voltage being measured.

Do not exceed the maximum signal levels of the test fixture, as shown on the rear panel and as defined in the specifications and operation section of the instruction manual.

Connect the screw of the test fixture to safety earth ground using #18 AWG or larger wire (supplied accessory).

Instrumentation and accessories should not be connected to humans.

The  symbol on a Model 237 indicates that 1000V or more may be present on the terminals. Refer to the Model 236/237/238 Operator's Manuals for detailed operation information.

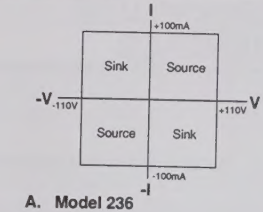
When a Model 236/237/238 is programmed for remote sensing, hazardous voltage may be present on the SENSE and OUTPUT terminals when the unit is in operate regardless of the programmed voltage or current. To avoid a possible shock hazard, always turn off all power before connecting or disconnecting cables to the Source Measure Unit or the associated test fixture.

For multiple unit interlocked test systems, either keep all Model 236/237/238s powered on, or turn them all off.

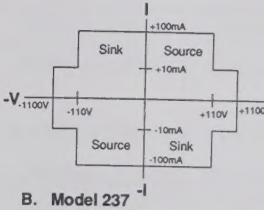
# SOURCE-MEASURE FUNDAMENTALS

**Table 1. Source-Measure Capabilities**

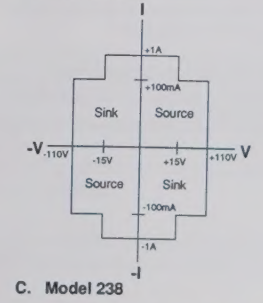
| | |
|---|---|
| Source V | ±100μV to ±110V |
| Measure I | ±10fA to ±100mA |
| Source I | ±100fA to ±100mA |
| Measure V | ±10μV to ±110V |
| 237 Additional Capabilities: Source or Measure up to ±1100V at ±10mA maximum<br><br>238 Additional Capabilities: Source or Measure up to ±1A at ±15V maximum. | |




A. Model 236




B. Model 237



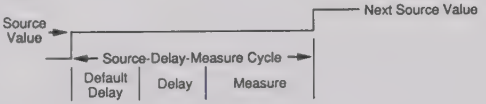

C. Model 238

**Figure 1. Source-Measure Capabilities**

# Source-Delay-Measure

Source Measure Unit operation (dc and sweep) consists of a series of source-delay-measure (SDM) cycles. During each SDM cycle, the following occurs:

Set the source output level.
Perform the delay.
Make the measurement.




**Default Delay** : Fixed delay for instrument settling.

**Delay** : Additional delay for device under test or system capacitance.

**Figure 2. Source-Delay-Measure (SDM) Cycle**

# Basic Circuit Configurations

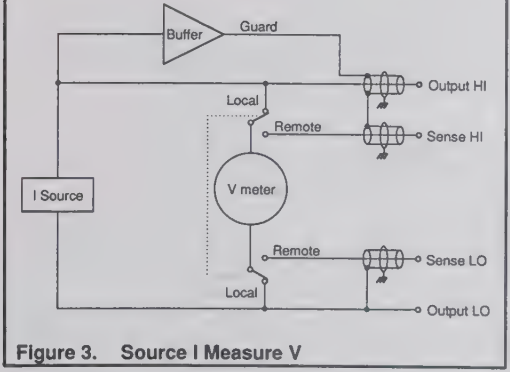



**Figure 3. Source I Measure V**

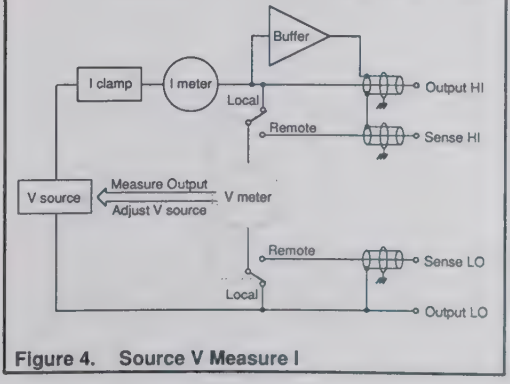



**Figure 4. Source V Measure I**

## Guard

The Source Measure Unit provides a driven guard for OUTPUT HI and SENSE HI. The driven guard is always enabled. When the Source Measure Unit is properly connected to a test fixture, guard is extended to that test fixture.

Guard should always be used when sourcing or measuring low current (<1μA) or for high speed measurements (SDM cycle <10msec).

**WARNING**

**GUARD is at the same potential as OUTPUT HI. Thus if lethal voltages are present at OUTPUT HI, they are also present at GUARD.**

## Basic Connections

**WARNING**

**Safe operation requires that a safety interlock switch be used to interrupt all power sources when the test fixture lid is open or ajar.**

**WARNING**

**With remote sensing enabled, an open sense lead will result in lethal voltages appearing at OUTPUT HI and GUARD. This**

**voltage can cause injury or death, and damage external circuitry. Always make sure that the sense leads are properly connected before enabling remote sense. NEVER change connections with power applied. Be sure to always discharge and/or disconnect external power sources.**

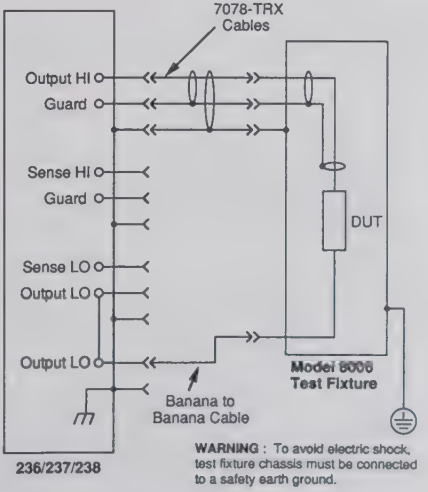



**Figure 5. Local Sense Connections Using Model 8006 Test Fixture**

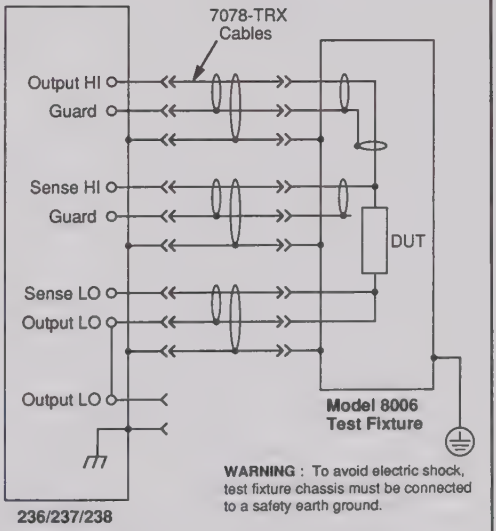



**Figure 6. Remote Sense Connections Using Model 8006 Test Fixture**

**Table 2. Display Messages**

| Message | Description |
|---|---|
| BUFFER FILLED | Number of generated sweep points exceeds the buffer capacity. |
| CAL CONSTANTS ERR | Power-up verification of cal constants finds one or more values outside of predetermined limits; default value(s) used for values out of limits. |
| CAL INVALID ERR | One or more cal errors present on power-up, DCL, or SDC. |
| DPRAM LINK ERR | Communication error in the dual port RAM between the I/O controller and source/measure controller. Unit is not functional. |
| DPRAM LOCKUP | ROM or RAM failure in source/measure controller so it is not responding to I/O controller. Unit is not functional. |
| GENERATING SWEEP | Unit is creating or appending a sweep from the front panel. |
| IDDC | Unit received an illegal device-dependent command. |

**Display Messages (Cont.)**

| Message | Description |
|---|---|
| IDDCO | Unit received an illegal device-dependent command option. |
| ILLEGAL MEAS RANGE | Select measure range is incompatible with source (V or I) or unit (236, 237, or 238). |
| ILLEGAL SRC RANGE | Select source range is incompatible with sourve (V or I) or unit (236, 237, or 238). |
| INTERLOCK PRESENT | Attempted to go into operate with an interlock condition present, or an interlock condition exists while in operate. |
| INVALID SWEEP MIX | Cannot create/append different sweep types (pulsed and non-pulsed) in buffer. |
| IOU CAL CHCKSUM | Power-up checksum test of cal constants failed. |
| IOU DPRAM FAILED | Dual port RAM in I/O controller failed. Unit is not functional. |
| IOU EEROM FAILED | Electrically erasable ROM in IOU controller failed. Unit is not functional. |
| LOG CANNOT CROSS 0 | Cannot create/append a log sweep that passes through zero. |

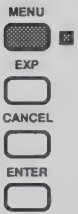
**Display Messages (Cont.)**

| Message | Description |
|---|---|
| MEAS RANGE CHANGED | Cannot have source and measure ranges of 1100V and 100mA (237), or 110V and 1A (238), at same time; measurement range lowered. |
| MUST CREATE SWEEP | Attempted to append or modify a non-existent sweep. |
| NO AUTO IN PULSE | Cannot select source autoranging with a pulse sweep create or append. |
| NOT IN REMOTE | Sent an X command when the unit was not in remote (REN is false). |
| OFLO | An external power source has overflowed the measurement hardware in the Model 236/237/238. |
| PULSE TIME NOT MET | Specified pulse times ($t_{ON}$ and $t_{OFF}$) cannot be met and will be extended. |
| PENDING TRIGGER | Waiting to finish previous operation before processing trigger. |
| TRIGGER OVERRUN | Unit was triggered while still processing a previous trigger; trigger is ignored. |
| UNCALIBRATED | No cal constants are stored in EEPROM (Source/Measure LED blinks). |

**Display Messages (Cont.)**

| Message | Description |
|---|---|
| VALUE OUT OF RANGE | Selected source value exceeds source range, or selected compliance value exceeds measurement range, or incremental source values are too small for selected range. |
| 236 UNIT | Sent 1kV calibration commands to a Model 236. |
| 65.000 SECONDS MAX | Cannot have a dc or sweep delay greater than 65.000 seconds. Value defaults to 65.000 seconds. |
| 1F | Power-up or memory test of IOU RAM failed. Unit is not functional. |
| 2F | Power-up memory test of IOU ROM failed. Unit is not functional. |

# MENU



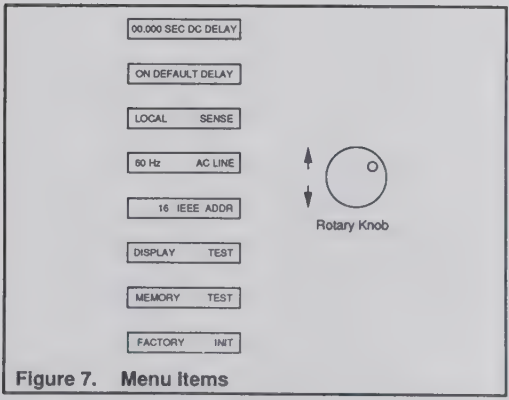




**Figure 7. Menu Items**

**Table 3. MENU Items Description**

| MENU Item | Description |
|---|---|
| Dc Delay | Used for dc operation. Provides additional time for source to settle. |
| Default Delay | Allows for internal settling on low current ranges. |
| Sense | Used to select local or remote sensing. Use remote sensing when sourcing or measuring >1mA (see next WARNING). |
| Ac Line | Use to set instrument to available line frequency (50 or 60Hz). Changing the line frequency also changes the integration time if LINE CYCLE PERIOD is presently selected (see ∫ Time). |
| IEEE Addr | Use to check or change IEEE-488 interface address (0 to 30). |
| Display Test | Turns on all display LED segments and front panel indicators. |
| Memory Test | Tests internal memory elements. |
| Factory Init | Restores factory default conditions. |

**WARNING**

**With remote sensing enabled, an open sense lead will result in lethal voltages appearing at OUTPUT HI and GUARD. This voltage can cause injury or death, and damage external circuitry. Always make sure that the sense leads are properly connected before enabling remote sense. Never change connections with power applied. Be sure to always discharge and/or disconnect external power sources.**

**Table 4. Default Delay**

| Range Source or Measure | Delay (msec) |
|---|---|
| 1nA | 360 |
| 10nA | 75 |
| 100nA | 20 |
| 1uA | 5 |
| 10uA | 2 |
| 100uA | 0 |
| 1mA | 0 |
| 10mA | 0 |
| 100mA | 0 |
| 1A | 0 |

## MENU Procedure

1. Press MENU.
2. Use the rotary knob to display the desired menu item

**NOTE**

To perform a self test or factory initialization, press ENTER.

3. To change a menu item parameter, use the keypad or SELECT buttons.
4. Press ENTER.
5. Repeat steps 2, 3 and 4 as needed. Exception: MENU will disable if FACTORY INIT is performed.
6. Press MENU to return to the source-measure display state.

## SOURCE AND FUNCTION

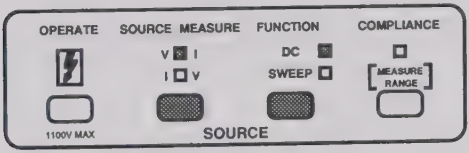


**Table 5. Voltage Source Ranges**

| Model | Range (Max Output) | Resolution |
|---|---|---|
| 236, 237<br>238 | ±1.1000V<br>±1.5000V | 100µV |
| 236, 237<br>238 | ±11.000V<br>±15.000V | 1mV |
| 236, 237, 238<br>237 | ±110.00V<br>±1100.0V | 10mV<br>100mV |

**Table 6. Current Source Ranges**

| Range (Max Output) | Resolution |
|---|---|
| ±1.0000nA | 100fA |
| ±10.000nA | 1pA |
| ±100.00nA | 10pA |
| ±1.0000µA | 100pA |
| ±10.000µA | 1nA |
| ±100.00µA | 10nA |
| ±1.0000mA | 100nA |
| ±10.000mA | 1µA |
| ±100.00mA | 10µA |
| ±1.0000A* | 100µA |

*Model 238 only

## Selecting Source and Function

The desired source (V or I) is selected by pressing SOURCE MEASURE, and function (dc or sweep) is selected by pressing FUNCTION. If the Manual Trigger light is blinking, press TRIGGER.

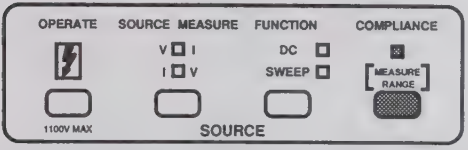
For dc operation, a source value can be set using the rotary knob and SELECT buttons, or by keying in a value from the keypad and pressing ENTER.

## Changing the Source Range (dc operation)

The position of the decimal point indicates the source range. For example, a reading of +002.00V indicates that the 110V range is selected, while a reading of +02.000V indicates that the 11V or 15V range is selected.

To select a different source range, use the SELECT buttons.◀ SELECT upranges and SELECT ▶ downranges.

# COMPLIANCE and MEASURE RANGE




Compliance limits are set in order to protect external circuitry (i.e. DUT) from damage. When sourcing voltage, a current compliance limit is set. Conversely, when sourcing current, a voltage compliance limit is set.

Setting compliance sets the maximum measurement range of the Source Measure Unit. A measurement range that is lower than the compliance value cannot be selected, unless AUTORANGE is enabled.

**Table 7. Current Measurement Ranges**

| Range (Max Output) | Resolution 4d | Resolution 5d |
|---|---|---|
| ±1nA | 100fA | 10fA |
| ±10nA | 1pA | 100fA |
| ±100nA | 10pA | 1pA |
| ±1μA | 100pA | 10pA |
| ±10μA | 1nA | 100pA |
| ±100μA | 10nA | 1nA |
| ±1mA | 100nA | 10nA |
| ±10mA | 1μA | 100nA |
| ±100mA | 10μA | 1μA |
| ±1A* | 100μA | 10μA |

*Model 238 only

**Table 8. Voltage Measurement Ranges**

| Model | Range (Max Output) | Resolution 4d | Resolution 5d |
|---|---|---|---|
| 236, 237<br>238 | ±1.1000V<br>±1.5000V | 100μV | 10μV |
| 236, 237<br>238 | ±11.000V<br>±15.000V | 1mV | 100μV |
| 236, 237, 238<br>237 | ±110.00V<br>±1100.0V | 10mV<br>100mV | 1mV<br>10mV |

## Changing Compliance Limit

Press COMPLIANCE to display the compliance limit. To change the limit, use the SELECT buttons and the rotary knob, or key in the value from the keypad and press ENTER.

## Measure Only

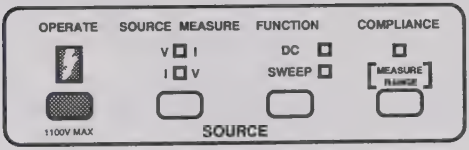
The Source Measure Unit can be used as a stand-alone voltmeter or current meter. To measure voltage, select Source I Measure V and set the current source to zero on the 1nA range (0.0000 nA). To measure current, select Source V Measure I and set the voltage source to zero on the 1.1V or 1.5V range (0.0000 V).

Note that positive current flows out of OUTPUT HI.

# AUTORANGE

With AUTORANGE enabled, the Source Measure Unit will go to the lowest possible (most sensitive) range to make the measurement. For example, with a 3V compliance limit (11V or 15V range), 0.5V will be measured on the 1.1V or 1.5V range if autorange is enabled.

# OPERATE




A source cannot be applied to the output unless the unit is in operate. The unit can be placed in standby (OPERATE light off) while the unit is in any display state. Toggling the sources (V to I, or I to V) will also place the unit in standby.

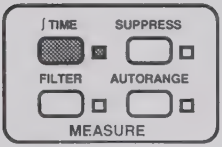
**DC Operation** — With the dc function selected, enabling operate will apply the source to the output, unless the MANUAL TRIGGER light is blinking. In this case, a trigger is needed to output the source and start making measurements.

**Sweep Operation** — With the sweep function selected, enabling OPERATE will source (but not measure) the bias level of the sweep. The sweep itself will not start until the appropriate trigger occurs (as denoted by the blinking MANUAL TRIGGER light).

**WARNING**

**To avoid electric shock, always assume that a hazardous voltage is applied to the output when OPERATE is enabled.**

## ∫ TIME




The integration (measure) time for A/D conversions and subsequent usable measurement resolution is selectable from the front panel and over the IEEE-488 bus. When LINECYCLE PERIOD is selected, the integration time depends on the line frequency setting (50 or 60Hz) of the Source Measure Unit (see MENU).

**Table 9. Integration Periods and Resolution**

| Selection | Integration Time | Measurement Resolution |
|---|---|---|
| FAST PERIOD | 416µsec | 4 digits |
| MEDIUM PERIOD | 4msec | 5 digits |
| LINE CYCLE PERIOD | 60Hz; 16.667msec<br>50Hz; 20msec | 5 digits |

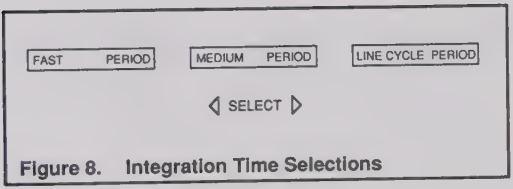
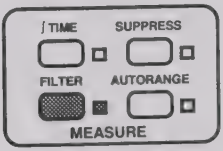



**Figure 8. Integration Time Selections**

## Changing ∫ Time

Press ∫ TIME to display the integration period. To change the period, use the SELECT buttons to display the desired period and press ENTER.

# FILTER




Filtering is used to stabilize noisy measurements. The unit does this by averaging a number of reading conversions and then displaying (or storing) the result. The number of readings that can be averaged (filtered) is 2, 4, 8, 16 or 32. FILTER disabled is synonymous to averaging one reading.

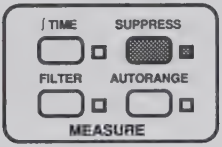
The more filtering used, the quieter the reading. However, filtering increases measurement time, thus decreasing

speed. As a general rule, only use as much filtering as necessary.

### Changing FILTER

Press FILTER to display the current filter selection. Use the SELECT buttons to display the desired selection and press ENTER.

## SUPPRESS




Suppression allows a stored offset value to be subtracted from subsequent measured readings. When SUPPRESS is enabled, the next conversion will be internally stored as a baseline. All subsequent readings will be the difference between the suppressed value and the actual signal level.

Suppressing a value while in dc operation will process readings already stored in the sweep buffer. The suppressed value will be algebraically subtracted from every measurement point in the sweep. This allows you to run a sweep and then afterwards use suppression to cancel an offset. When SUPPRESS is later disabled, the readings in the sweep buffer will return to the original measured values.

The first measurement point of a sweep can be used as the baseline. Prior to starting the sweep, enabling SUPPRESS

will cause its light to start blinking, indicating that it is waiting for a trigger to start the sweep. When the sweep is started, the first measurement point is stored as the baseline, and subsequent measured points reflect this suppressed value. If SUPPRESS is disabled after the sweep is completed, the readings in the sweep buffer will return to the originally measured values.

**WARNING**

**Voltage on the output may be larger than the displayed measured value. For example, if a 75V baseline is stored, a voltage of +100V will result in a displayed measured value of only +25V.**

# SWEEP OPERATION

## Performing A Sweep

With the Source Measure appropriately configured, a sweep is performed by placing the unit in OPERATE and providing the trigger(s) needed to start/control the sweep.

The following steps summarize the basic steps to perform a sweep:

Before using the Source Measure Unit, make sure it is properly connected.

**Step 1. Select Source and Sweep Function**

To sweep voltage, select Source V Measure I, or to sweep current, select Source I Measure V.

**Step 2. Configure Miscellaneous Features and Controls**

Features/controls that you may wish to configure or check include; IEEE address (for bus operation), default delay,

sense, integration time, and filter.

**Step 3. Create Sweep**

**Step 4. Append/Modify Sweep (optional)**

If desired, the basic sweep created in step 5 can be customized using the append and modify features.

**Step 5. Enter Compliance Value**

Enter an appropriate compliance value and select an appropriate measurement range.

**Step 6. Configure Triggers**

**Step 7. Place Unit in OPERATE**

**Step 8. Provide Input Trigger(s)**

Depending on how the triggers are configured, one or more input triggers will process the sweep.

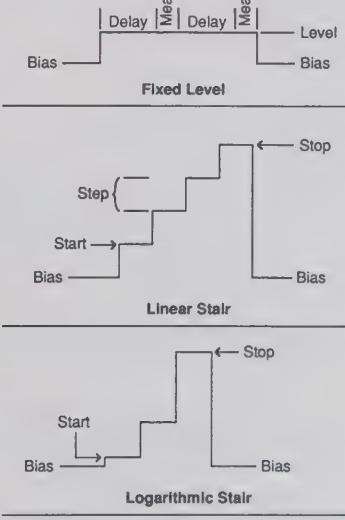
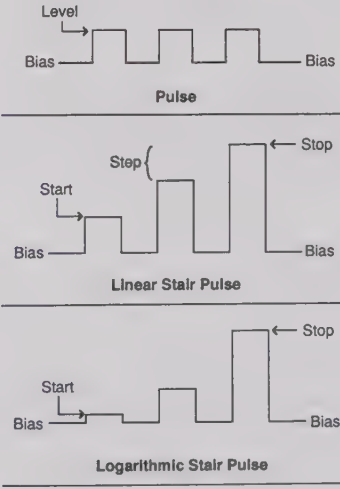



**Figure 9. Sweep Waveforms**




**Sweep Waveforms (Cont.)**

# CREATE SWEEP

**Step 1. Select Source**

To sweep (source) voltage, the Source Measure Unit must be in Source V Measure I. Conversely, to sweep (source) current, the Source Measure Unit must be in Source I Measure V.

**Step 2. Enable Sweep CREATE**

The currently defined sweep waveform will be displayed.

**Step 3. Select Sweep Waveform**

Figure 9 shows the sweep waveform selections. Use the SELECT buttons to display the desired sweep waveform and then press ENTER.

**Step 4. Define Sweep Parameters**

Any parameter of the sweep can be displayed using the rotary knob. Changes to all parameters, except points/decade and range, are accomplished by using the keypad to key-in the value and pressing ENTER. Changes to the points/decade and range parameters are accomplished using the SELECT buttons to display the parameter option and pressing ENTER.

**Step 5. Save Sweep Parameters**

In order to save sweep parameters, the message "SAVE? ENTER/CANCEL" must be displayed. This message is dis-

played after the range parameter is entered. It can also be displayed by again pressing CREATE.

With "SAVE? ENTER/CANCEL" displayed, press ENTER to save the sweep parameters. Pressing CANCEL will maintain the sweep with the previously programmed definition.

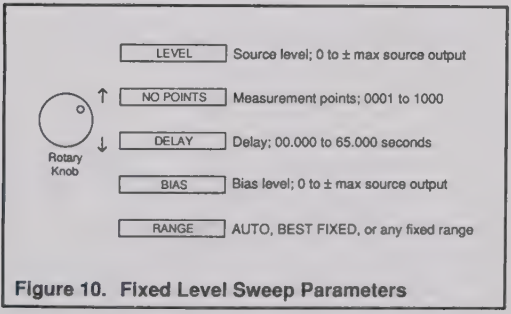



**Figure 10. Fixed Level Sweep Parameters**

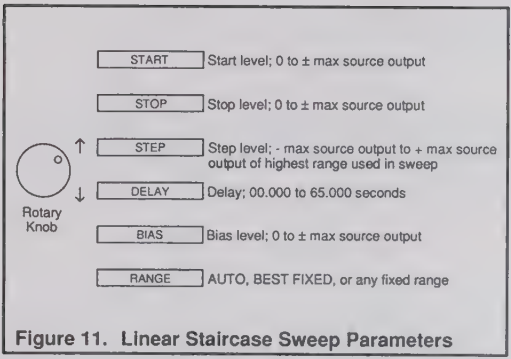

START
Start level; 0 to ± max source output
STOP
Stop level; 0 to ± max source output
STEP
Step level; - max source output to + max source output of highest range used in sweep
DELAY
Delay; 00.000 to 65.000 seconds
Rotary Knob
BIAS
Bias level; 0 to ± max source output
RANGE
AUTO, BEST FIXED, or any fixed range

**Figure 11. Linear Staircase Sweep Parameters**

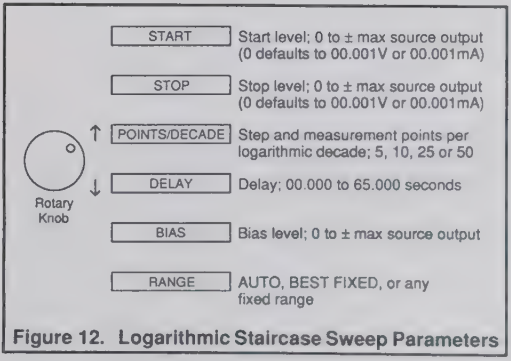

START
Start level; 0 to ± max source output (0 defaults to 00.001V or 00.001mA)
STOP
Stop level; 0 to ± max source output (0 defaults to 00.001V or 00.001mA)
POINTS/DECADE
Step and measurement points per logarithmic decade; 5, 10, 25 or 50
DELAY
Delay; 00.000 to 65.000 seconds
Rotary Knob
BIAS
Bias level; 0 to ± max source output
RANGE
AUTO, BEST FIXED, or any fixed range

**Figure 12. Logarithmic Staircase Sweep Parameters**

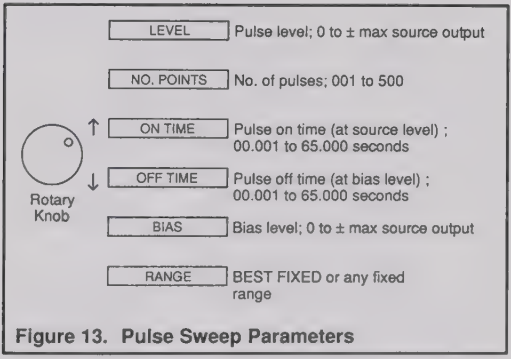

LEVEL
Pulse level; 0 to ± max source output
NO. POINTS
No. of pulses; 001 to 500
ON TIME
Pulse on time (at source level) ; 00.001 to 65.000 seconds
OFF TIME
Pulse off time (at bias level) ; 00.001 to 65.000 seconds
Rotary Knob
BIAS
Bias level; 0 to ± max source output
RANGE
BEST FIXED or any fixed range

**Figure 13. Pulse Sweep Parameters**

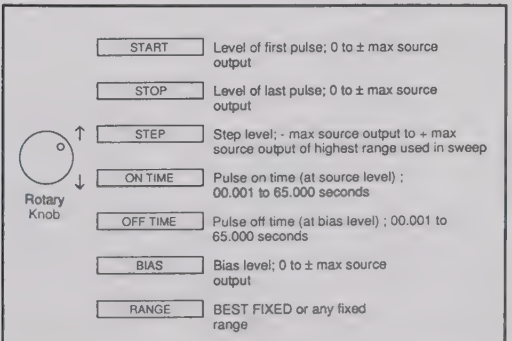

START
Level of first pulse; 0 to ± max source output
STOP
Level of last pulse; 0 to ± max source output
STEP
Step level; - max source output to + max source output of highest range used in sweep
ON TIME
Pulse on time (at source level) ; 00.001 to 65.000 seconds
Rotary Knob
OFF TIME
Pulse off time (at bias level) ; 00.001 to 65.000 seconds
BIAS
Bias level; 0 to ± max source output
RANGE
BEST FIXED or any fixed range

**Figure 14. Linear Staircase Pulse Sweep Parameters**

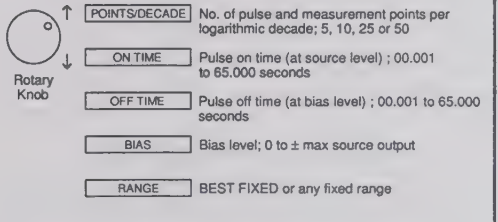

START
Level of first pulse; 0 to ± max source output (0 defaults to 00.001V or 00.001mA)
STOP
Level of last pulse; 0 to ± max source output (0 defaults to 00.001V or 00.001mA)
POINTS/DECADE
No. of pulse and measurement points per logarithmic decade; 5, 10, 25 or 50
ON TIME
Pulse on time (at source level) ; 00.001 to 65.000 seconds
OFF TIME
Pulse off time (at bias level) ; 00.001 to 65.000 seconds
BIAS
Bias level; 0 to ± max source output
RANGE
BEST FIXED or any fixed range
Rotary Knob

**Figure 15. Logarithmic Staircase Pulse Sweep Parameters**

# APPEND SWEEP

The append feature permits one or more waveforms to be appended to the currently defined sweep waveform.

**Table 10. APPEND Waveform**

| Defined Sweep Waveform | Available APPEND Sweep Waveforms |
|---|---|
| Fixed level | Fixed level<br>Linear staircase<br>Log staircase |
| Linear staircase | Fixed level<br>Linear staircase<br>Log staircase |
| Log staircase | Fixed level<br>Linear staircase<br>Log staircase |
| Pulse | Pulse<br>Linear staircase pulse<br>Log staircase pulse |
| Linear staircase pulse | Pulse<br>Linear staircase pulse<br>Log staircase pulse |
| Log staircase pulse | Pulse<br>Linear staircase pulse<br>Log staircase pulse |

Perform the following steps to append a sweep:

**Step 1. Enable Sweep APPEND**

The same type of sweep that is already defined will be displayed.

If appending the defined sweep with the same (displayed) sweep type, proceed to step 3.

**Step 2. Select Sweep Type**

Use the SELECT buttons to display the sweep type that you wish to append to the already defined sweep and press ENTER.

**Step 3. Define Sweep Parameters**

These sweep parameters are entered in the same way that parameters were entered for the original sweep.

**Step 4. Save Sweep Parameters**

Sweep parameters are saved in the same way that the original sweep parameters were saved.

## MODIFY SWEEP

The modify feature permits source level and delay time changes to be made for any measurement point in the cur-

rently defined sweep. This feature allows custom shaped waveforms to be fabricated.

**Step 1. Enable Sweep MODIFY.**

The source level at the first measure point will be displayed.

**Step 2. Modify Source Levels**

The rotary knob will display the source level for each measure point in the sweep. To change a source level, perform the following steps:

1. Use the rotary knob to display the measure point .
2. Key-in the new source level from the keypad.
3. Press ENTER. The source range for the original source level will be displayed.
4. If an alternate source range is needed or desired, use the SELECT buttons to display it.
5. Press ENTER. The newly entered source value will be displayed.
6. Repeat steps 1 through 5 to change the source level at another measure point.

**Step 3. Modify Delay Times**

If one or more delay times are going to be changed, perform the following steps. Otherwise, proceed to step 4.

1. Press SELECT▶. The delay time for one of the measure points will be displayed.
2. Use the rotary knob to display the measure point whose delay is to be changed.

3. Key-in the new delay time from the keypad.
4. Press ENTER. The newly entered delay time will be displayed.
5. Repeat steps 1 through 4 to change the delay time at another measure point.

**Step 4. Exit Modify State**

To return the Source Measure Unit to the normal source-measure display state press either Sweep MODIFY or ENTER.

## TRIGGER SETUP

**Input Triggers** — Input triggers are used to control when source, delay, and measure operations occur.

**Input Trigger Origin** — The input trigger stimulus may be provided by the front panel MANUAL trigger button, an external device that applies a TTL level pulse to the TRIGGER IN connector on the rear panel, or an appropriate IEEE-488 operation.

**Output Triggers** — The Source Measure Unit is capable of sending TTL level output pulses (via its TRIGGER OUT connector) to trigger operations of external devices, such as another Source Measure Unit. The Source Measure Unit can be programmed to output a trigger after any phase of the SDM cycle.

**Sweep End Output Trigger** — In addition to the previously mentioned output triggers, the Source Measure Unit can

also be programmed to output a trigger pulse at the end of a sweep.

**Enable/Disable Triggers** — Input and output triggers of the Source Measure Unit can be disabled by the enable/disable triggers setup.

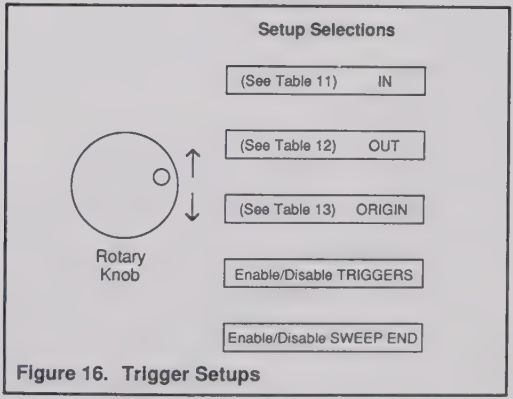



**Figure 16. Trigger Setups**

**Table 11. Input Triggers**

| Trigger Selection | | Description |
|---|---|---|
| CONTINUOUS | IN | Continuously process all SDM cycles. |
| ^SRC DLY MSR | IN | Each trigger will process an SDM cycle. |
| SRC^DLY MSR | IN | Initial trigger sets source. Each subsequent trigger initiates a delay and measure, then sets source of next SDM cycle. |
| ^SRC^DLY MSR | IN | Two triggers process each SDM cycle. First trigger sets source. Second trigger initiates a delays and measure. |
| SRC DLY^MSR | IN | Initial trigger sets source and causes a delay. Second trigger initiates measure, and then, for next SDM cycle, sets source and initiates a delay. |
| ^SRC DLY^MSR | IN | Two triggers process each SDM cycle. First trigger sets source and initiates a delay. Second trigger initiates a measure. |

## Input Triggers (Cont.)

| Trigger Selection | Description |
|---|---|
| SRC^DLY^MSR IN | Initial trigger sets source. Two triggers process each SDM cycle. First trigger initiates a delay. Second trigger initiates a measure and sets source of next SDM cycle. |
| ^SRC^DLY^MSR IN | Three triggers process each SDM cycle. First trigger sets source. Second trigger initiates a delay. Third trigger initiates a measure. |
| ^SINGLE PULSE IN | Pulse sweep trigger. Each trigger processes the on time ($t_{ON}$) and off time ($t_{OFF}$) of each pulse in the sweep. Two measurements are made on each pulse. |

**Table 12. Output Triggers**

| Trigger Selection | | Description |
|---|---|---|
| NONE | OUT | No output triggers. |
| SRC▲DLY MSR | OUT | Output trigger pulse after every source phase. |
| SRC DLY▲MSR | OUT | Output trigger pulse after every delay phase. |
| SRC▲DLY▲MSR | OUT | Output trigger pulse after every source phase and delay phase. |
| SRC DLY MSR▲ | OUT | Ouptut trigger pulse after every measure phase. |
| SRC▲DLY MSR▲ | OUT | Output trigger pulse after every source phase and measure phase. |
| SRC DLY▲MSR▲ | OUT | Output trigger pulse after every delay phase and measure phase. |
| SRC▲DLY▲MSR▲ | OUT | Output trigger pulse after every source phase, delay phase, and measurement phase. |
| PULSE END▲ | OUT | For pulse sweeps. Output trigger pulse after end of each off time ($t_{OFF}$) measurement. |
| SWEEP END▲<br>Separate output trigger that is not displayed with the other output triggers (see Figure 16) | | When enable, an output trigger pulse occurs at the end of the sweep. |

**Table 13. Input Trigger Origin**

| Selection | Trigger Stimulus |
|---|---|
| INTERNAL ORIGIN | Front panel MANUAL trigger button or H0 command over IEEE-488 bus. |
| EXTERNAL ORIGIN | Negative-going TTL level pulse applied to TRIGGER IN connector. |
| IEEE TALK ORIGIN | Unit addressed to talk over IEEE-488 bus. |
| IEEE GET ORIGIN | Group execute trigger (GET) command sent over IEEE-488 bus. |
| IEEE X ORIGIN | "X" sent over IEEE-488 bus. |

Note: Front panel MANUAL trigger button or H0 Command will provide an input trigger with any trigger origin.

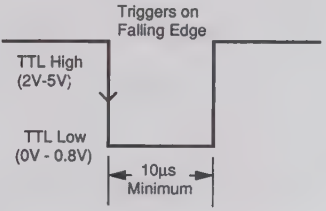



**Figure 17. External Input Trigger Pulse Specification**

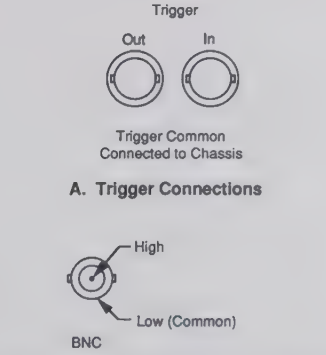



**Figure 18. Trigger In and Trigger Out Connections**

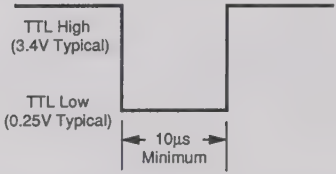



**Figure 19. External Output Trigger Pulse Specifications**

# RECALL SWEEP

Every measurement that occurs in a sweep is stored in the sweep buffer and time stamped. Each time stamp indicates the elapsed time from the start of the sweep to the end of the measurement.

Data is structured in a matrix array. The display of the Source Measure Unit serves as a "window" to view each piece of data in the matrix. When the Source Measure Unit is in SWEEP RECALL, the display "window" is moved around in the matrix with the DATA ENTRY rotary knob and SELECT buttons. The rotary knob moves the "window" vertically, while the SELECT buttons moves the "window" horizontally in the array.

**Figure 20. Sweep Buffer Data**

# IEEE-488 PROGRAMMING

## DEVICE-DEPENDENT COMMANDS

**Modify Sweep List**

A(level),(range),(delay),first(,last)

*level* — Output level of sweep source:

| | | |
|---|---|---|
| I-source | (236, 237) | –100.00 to +100.00mA |
| | (238) | –1.0000 to +1.0000A |
| V-source | (236, 238) | –110.00 to +110.00V |
| | (237) | –1100.0 to +1100.0V |

*range* — Source range:

| | I-source | V-source |
|---|---|---|
| 0 = | Auto | Auto |
| 1 = | 1nA | 1.1V (236, 237); 1.5V (238) |
| 2 = | 10nA | 11V (236, 237); 15V (238) |
| 3 = | 100nA | 110V |
| 4 = | 1µA | 1100V (237) |
| 5 = | 10µA | * |
| 6 = | 100µA | * |
| 7 = | 1mA | * |
| 8 = | 10mA | * |
| 9 = | 100mA | * |
| 10 = | 1A (238) | * |

*Illegal V-source option.

*delay* — Sweep delay in msec (0-65000)

*first* — First data point (1-1000)
*last* — Last data point (1-1000)

**Bias Operation**

B(level),(range),(delay)

*level* — Output level of dc source:

| | | |
|---|---|---|
| I-source | (236, 237) | –100.00 to +100.00mA |
| | (238) | –1.0000 to +1.0000A |
| V-source | (236, 238) | –110.00 to +110.00V |
| | (237) | –1100.0 to +1100.0V |

*range* — Source range:

| | I-source | V-source |
|---|---|---|
| 0 = | Auto | Auto |
| 1 = | 1nA | 1.1V (236, 237); 1.5V (238) |
| 2 = | 10nA | 11V (236, 237); 15V (238) |
| 3 = | 100nA | 110V |
| 4 = | 1μA | 1100V (237) |
| 5 = | 10μA | * |
| 6 = | 100μA | * |
| 7 = | 1mA | * |
| 8 = | 10mA | * |
| 9 = | 100mA | * |
| 10 = | 1A (238) | * |

*Illegal V-source option.

*delay* — Dc delay in msec (0-65000)

| Calibration | |
|---|---|
| Cstep(,value)X | |
| C0X | Enter calibration procedure |
| C1X | Common mode adjustment |
| C2X | Set up +1.1V (236, 237) or +1.5V (238) source and measure offset calibration |
| C3,VmsrX | Vmsr = Measured voltage |
| C4X | Set up +1.1V (236, 237) or +1.5V (238) source and measure gain calibration |
| C5,VmsrX | Vmsr = Measured voltage |
| C6X | Set up –1.1V (236, 237) or –1.5V (238) source and measure offset calibration |
| C7,VmsrX | Vmsr = Measured voltage |
| C8X | Set up –1.1V (236, 237) or –1.5V (238) source and measure gain calibration |
| C9,VmsrX | Vmsr = Measured voltage |
| C10X | Set up +11V (236, 237) or +15V (238) source and measure offset calibration |
| C11,VmsrX | Vmsr = Measured voltage |
| C12X | Set up +11V (236, 237) or +15V (238) source and measure gain calibration |
| C13,VmsrX | Vmsr = Measured voltage |
| C14X | Set up –11V (236, 237) or –15V (238) source and measure offset calibration |
| C15,VmsrX | Vmsr = Measured voltage |
| C16X | Set up –11V (236, 237) or –15V (238) source and measure gain calibration |
| C17,VmsrX | Vmsr = Measured voltage |
| C18X | Set up +110V source and measure offset calibration |
| C19,VmsrX | Vmsr = Measured voltage |
| C20X | Set up +110V source and measure gain calibration |

| Calibration (Cont.) | |
|---|---|
| C21,VmsrX | Vmsr = Measured voltage |
| C22X | Set up –110V source and measure offset calibration |
| C23,VmsrX | Vmsr = Measured voltage |
| C24X | Set up –110V source and measure gain calibration |
| C25,VmsrX | Vmsr = Measured voltage |
| | **237/238 only** |
| C26X | Set up +1.1kV (237) or +1A (238) source and measure offset calibration |
| C27,msrX | msr = Measured voltage (237) or current (238) |
| C28X | Set up +1.1kV (237) or +1A (238) source and measure gain calibration |
| C29,msrX | msr = Measured voltage (237) or current (238) |
| C30X | Set up –1.1kV (237) or –1A (238) source and measure offset calibration |
| C31,msrX | msr = Measured voltage (237) or current (238) |
| C32X | Set up –1.1kV (237) or –1A (238) source and measure gain calibration |
| C33,msrX | msr = Measured voltage (237) or current (238) |
| C34X | Set up +100mA source and measure offset calibration |
| C35,ImsrX | Imsr = Measured current |
| C36X | Set up +100mA source and measure gain calibration |
| C37,ImsrX | Imsr = Measured current |
| C38X | Set up –100mA source and measure offset calibration |
| C39,ImsrX | Imsr = Measured current |

| Calibration (Cont.) | |
|---|---|
| C40X | Set up –100mA source and measure gain calibration |
| C41,ImsrX | Imsr = Measured current |
| C42X | Perform 1nA measure offset calibration |
| C43,IsrcX | Perform 1nA measure gain calibration, Isrc = Sourced current |
| C44X | Perform 10nA measure offset calibration |
| C45,IsrcX | Perform 10nA measure gain calibration, Isrc = Sourced current |
| C46X | Perform 100nA measure offset calibration |
| C47,IsrcX | Perform 100nA measure gain calibration, Isrc = Sourced current |
| C48X | Perform 1μA measure offset calibration |
| C49,IsrcX | Perform 1μA measure gain calibration, Isrc = Sourced current |
| C50X | Perform 10μA measure offset calibration |
| C51,IsrcX | Perform 10μA measure gain calibration, Isrc = Sourced current |
| C52X | Perform 100μA measure offset calibration |
| C53,IsrcX | Perform 100μA measure gain calibration, Isrc = Sourced current |
| C54X | Perform 1mA measure offset calibration |
| C55,IsrcX | Perform 1mA measure gain calibration, Isrc = Sourced current |
| C56X | Perform 10mA measure offset calibration |
| C57,IsrcX | Perform 10mA measure gain calibration, Isrc = Sourced current |
| C58X | Perform 1nA to 10mA source calibration |
| C59X | Exit calibration procedure |

**Display**

| | |
|---|---|
| D0X | Return display to normal operation |
| D1,aaa...aX | Display ASCII characters (18 max.) |
| D2,aaa...aX | Display ASCII characters and store in memory (18 max.) |

**Source and Function**

F(source),(function)

| | | | |
|---|---|---|---|
| F0,0 | Source V | Measure I | dc |
| F0,1 | Source V | Measure I | Sweep |
| F1,0 | Source I | Measure V | dc |
| F1,1 | Source I | Measure V | Sweep |

**Output Data Format**

G(items),(format),(lines)

*items* — Sum of items in IEEE output string (0–15):
0 = No items
1 = Source value
2 = Delay value
4 = Measure value
8 = Time value

*format* — Format of IEEE output string:
0 = ASCII data with prefix and suffix
1 = ASCII data with prefix, no suffix
2 = ASCII data, no prefix or suffix
3 = HP binary data
4 = IBM binary data

| Output Data Format (Cont.) |
|---|
| *lines* — Number of lines per output:<br>0 = One line of dc data per talk<br>1 = One line of sweep data per talk<br>2 = All lines of sweep data per talk |

| IEEE Immediate Trigger | |
|---|---|
| H0X | Cause immediate trigger |

| Self-tests | |
|---|---|
| J0X | Restore factory defaults |
| J1X | Perform memory test |
| J2X | Perform display test |

| EOI and Bus Hold-off | | |
|---|---|---|
| K0 | Enable EOI | Enable bus hold-off on X |
| K1 | Disable EOI | Enable bus hold-off on X |
| K2 | Enable EOI | Disable bus hold-off on X |
| K3 | Disable EOI | Disable bus hold-off on X |

**Compliance**

L(level),(range)

*level* — Compliance level:

| | | |
|---|---|---|
| I-measure | (236, 237) | –100.00 to +100.00mA |
| | (238) | –1.0000 to +1.0000A |
| V-measure | (236, 238) | –110.00 to +110.00V |
| | (237) | –1100.0 to +1100.0V |

*range* — Compliance/measurement range:

| | I-measure | V-measure |
|---|---|---|
| 0 = | Auto | Auto |
| 1 = | 1nA | 1.1V (236, 237); 1.5V (238) |
| 2 = | 10nA | 11V (236, 237); 15V (238) |
| 3 = | 100nA | 110V |
| 4 = | 1µA | 1100V (237) |
| 5 = | 10µA | * |
| 6 = | 100µA | * |
| 7 = | 1mA | * |
| 8 = | 10mA | * |
| 9 = | 100mA | * |
| 10 = | 1A (238) | * |

*Illegal V-measure option.

**SRQ Mask and Serial Poll Byte**

M(mask),(compliance)

*mask* — Sum of bits in SRQ mask:
0 = SRQ disabled
1 = Warning
2 = Sweep Done
4 = Trigger Out
8 = Reading Done
16 = Ready for Trigger
32 = Error
128 = Compliance

*compliance* — SRQ on compliance:
0 = During delay or measure phase or idle time
1 = During measure phase

**Operate**

| | |
|---|---|
| N0 | Standby |
| N1 | Operate |

**Output Sense**

| | |
|---|---|
| O0 | Local sense |
| O1 | Remote sense |

| Filter | |
|---|---|
| P0 | Filter disabled |
| P1 | 2 readings |
| P2 | 4 readings |
| P3 | 8 readings |
| P4 | 16 readings |
| P5 | 32 readings |

**Create/Append Sweep List**

Q0,(level),(range),(delay),(count)
Create fixed level sweep
Q1,(start),(stop),(step),(range),(delay)
Create linear stair sweep
Q2,(start),(stop),(points),(range),(delay)
Create logarithmic stair sweep
Q3,(level),(range),(pulses),($t_{ON}$),($t_{OFF}$)
Create fixed level pulsed sweep
Q4,(start),(stop),(step),(range),($t_{ON}$),($t_{OFF}$)
Create linear stair pulsed sweep
Q5,(start),(stop),(points),(range),($t_{ON}$),($t_{OFF}$)
Create logarithmic stair pulsed sweep

Q6,(level),(range),(delay),(count)
Append fixed level sweep
Q7,(start),(stop),(step),(range),(delay)
Append linear stair sweep
Q8,(start),(stop),(points),(range),(delay)
Append logarithmic stair sweep
Q9,(level),(range),(pulses),($t_{ON}$),($t_{OFF}$)
Append fixed level pulsed sweep
Q10,(start),(stop),(step),(range),($t_{ON}$),($t_{OFF}$)
Append linear stair pulsed sweep
Q11,(start),(stop),(points),(range),($t_{ON}$),($t_{OFF}$)
Append logarithmic stair pulsed sweep

**Create/Append Sweep List (Cont.)**

*count* — Number of S-D-M cycles in sweep (1-1000)

*delay* — Sweep delay in msec (0-65000)

*level* — Output level of sweep source:

| | | |
|---|---|---|
| I-source | (236, 237) | –100.00 to +100.00mA |
| | (238) | –1.0000 to +1.0000A |
| V-source | (236, 238) | –110.00 to +110.00V |
| | (237) | –1100.0 to +1100.0V |

*points* — Logarithmic points per decade:
0 = 5 points/decade
1 = 10 points/decade
2 = 25 points/decade
3 = 50 points/decade

*pulses* — Pulse quantity (0-500)

*range* — Source range:

| | I-source | V-source |
|---|---|---|
| 0 = | Auto** | Auto** |
| 1 = | 1nA | 1.1V (236, 237); 1.5V (238) |
| 2 = | 10nA | 11V (236, 237); 15V (238) |
| 3 = | 100nA | 110V |
| 4 = | 1μA | 1100V (237) |
| 5 = | 10μA | * |
| 6 = | 100μA | * |
| 7 = | 1mA | * |
| 8 = | 10mA | * |
| 9 = | 100mA | * |
| 10 = | 1A (238) | * |

*Illegal V-source option.
**No pulsed sweeps

| Create/Append Sweep List (Cont.) | | |
|---|---|---|
| *start, stop* — Start and stop source values for stair sweeps. | | |
| I-source | (236, 237) | –100.00 to +100.00mA |
| | (238) | –1.0000 to +1.0000A |
| V-source | (236, 238) | –110.00 to +110.00V |
| | (237) | –1100.0 to +1100.0V |
| *step* — Incremental absolute value for stair sweeps. | | |
| I-source | (236, 237) | –200.00 to +200.00mA |
| | (238) | –2.0000 to +2.0000A |
| V-source | (236, 238) | –220.00 to +220.00V |
| | (237) | –2200.0 to +2200.0V |
| $t_{ON}$ — Duration of sweep level in msec (0-65000) | | |
| $t_{OFF}$ — Duration of bias level in msec (0-65000) | | |

| Trigger Control | |
|---|---|
| R0 | Disable input triggering and generation of output triggers |
| R1 | Enable input triggering and generation of output triggers |

| Integration Time | |
|---|---|
| S0 | 416µsec integration time, Fast, 4-digit resolution |
| S1 | 4msec integration time, Medium, 5-digit resolution |
| S2 | 16.67msec integration time, 60Hz ac line, 5-digit resolution |
| S3 | 20msec integration time, 50Hz ac line, 5-digit resolution |

**Trigger Configuration (Cont.)**

T(origin),(in),(out),(end)

*origin* — Input trigger origin:
0 = IEEE X
1 = IEEE GET
2 = IEEE Talk
3 = External (TRIGGER IN pulse)
4 = Immediate only (MANUAL key or H0X command)

*in* — Input trigger effect:
0 = Continuous (no trigger needed to continue S-D-M)
1 = ^SRC DLY MSR (trigger starts source)
2 = SRC^DLY MSR (trigger starts delay)
3 = ^SRC^DLY MSR
4 = SRC DLY^MSR (trigger starts measure)
5 = ^SRC DLY^MSR
6 = SRC^DLY^MSR
7 = ^SRC^DLY^MSR
8 = ^Single Pulse

*out* — Output trigger generation:
0 = None during sweep
1 = SRC^DLY MSR (end of source)
2 = SRC DLY^MSR (end of delay)
3 = SRC^DLY^MSR
4 = SRC DLY MSR^ (end of measure)
5 = SRC^DLY MSR^
6 = SRC DLY^MSR^
7 = SRC^DLY^MSR^
8 = Pulse End^

*end* — Sweep End^ trigger out:
0 = Disabled
1 = Enabled

| Status | |
|---|---|
| U0 | Send model number and firmware revision |
| U1 | Send error status word |
| U2 | Send stored ASCII string ("D2" command string) |
| U3 | Send machine status word |
| U4 | Send measurement parameters |
| U5 | Send compliance value |
| U6 | Send suppression value |
| U7 | Send calibration status word |
| U8 | Send defined sweep size |
| U9 | Send warning status word |
| U10 | Send first sweep point in compliance |
| U11 | Send sweep measure size |

| 1100V Range Control | 237 only |
|---|---|
| V0 | Disable 1100V range |
| V1 | Enable 1100V range |

| Default Delay | |
|---|---|
| W0 | Disable default delay |
| W1 | Enable default delay |

| Execute | |
|---|---|
| X | Execute commands |

| Terminator | |
|---|---|
| Y0 | <CR><LF> |
| Y1 | <LF><CR> |
| Y2 | <CR> |
| Y3 | <LF> |
| Y4 | none |

| Suppress | |
|---|---|
| Z0 | Disable suppression |
| Z1 | Enable suppression |

**Table 14. Order of Command Execution**

| Order | Command | Description |
|---|---|---|
| 1 | M | Set the SRQ mask |
| 2 | C | Calibration sequence |
| 3 | F | Set source and function |
| 4 | O | Program local/remote sense |
| 5 | P | Select filter |
| 6 | Z | Program suppression |
| 7 | S | Set integration time |
| 8 | W | Enable/disable default delay |
| 9 | L | Program compliance |
| 10 | B | Program bias operation |
| 11 | Q | Create/append sweep list |
| 12 | A | Modify sweep list |
| 13 | T | Select trigger configuration |
| 14 | R | Enable/disable triggers |
| 15 | N | Select operate/standby mode |
| 16 | D | Display a user message |
| 17 | Y | Select terminator characters |
| 18 | K | Select EOI and hold-off on X |
| 19 | G | Select output data format |
| 20 | V | 1100V Range Control |
| 21 | J | Execute self-tests |
| 22 | U | Request status |
| 23 | H | Send IEEE immediate trigger |
| 24 | X | Execute DDCs |

# DATA FORMATS




**Figure 21. ASCII Data Format (G15,0,0)**

**Figure 22. Binary Data Format (G15,3,0 and G15,4,0)**

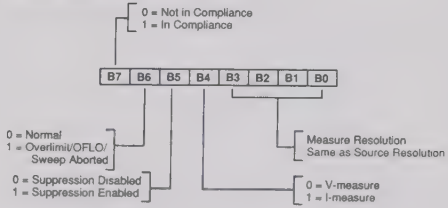
NOTES:

1. The byte count is the total number of bytes not including terminators.

2. Source Resolution:

| | | |
|---|---|---|
| 0 = | E–14 amps | E–5 volts |
| 1 = | E–13 amps | E–4 volts |
| 2 = | E–12 amps | E–3 volts |
| 3 = | E–11 amps | E–2 volts |
| 4 = | E–10 amps | E–1 volts |
| 5 = | E–9 amps | |
| 6 = | E–8 amps | |
| 7 = | E–7 amps | |
| 8 = | E–6 amps | |
| 9 = | E–5 amps | |
| 10 = | E–4 amps | |

3. Measure Status and Resolution:




4 Terminator characters are selected with the Y command. They should not be used to terminate a binary transfer.

5. Expressed as integer milliseconds.

## Binary Data Format (G15,3,0 and G15,4,0) (Cont.)

# SRQ MASK and SERIAL POLL BYTE


B7 B6 B5 B4 B3 B2 B1 B0
0/1 0/1 0/1 0/1 0/1 0/1 0/1 0/1
128 64 32 16 8 4 2 1
1 = Compliance
1 = SRQ by 236/237/238 (Serial Poll Byte Only)
1 = Error
1 = Ready for Trigger
1 = Warning
1 = Sweep Done
1 = Trigger Out
1 = Reading Done

**Figure 23. SRQ Mask and Serial Poll Byte Format**

# STATUS WORDS

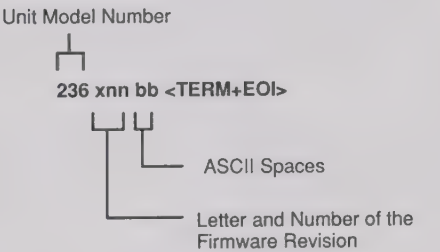
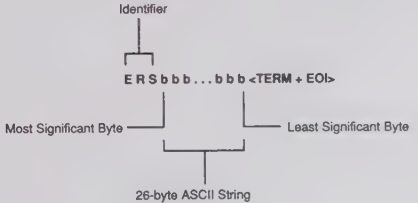



**Figure 24. U0 Model Number and Firmware Revision**




| | |
|---|---|
| **Most Significant Byte** | Trigger Overrun |
| | IDDC |
| | IDDCO |
| | Interlock Present |
| | Illegal Measure Range |
| | Illegal Source Range |
| | Invalid Sweep Mix |
| | Log Cannot Cross Zero |
| | Autoranging Source with Pulse Sweep |
| | In Calibration |
| | In Standby |
| | Unit is a 236 |
| | IOU DPRAM Failed |
| | IOU EEROM Failed |
| | IOU Cal Checksum Error |
| | DPRAM Lockup |
| | DPRAM Link Error |
| | Cal ADC Zero Error |
| | Cal ADC Gain Error |
| | Cal SRC Zero Error |
| | Cal SRC Gain Error |
| | Cal Common Mode Error |
| | Cal Compliance Error |
| | Cal Value Error |
| | Cal Constants Error |
| **Least Significant Byte** | Cal Invalid Error |

**Figure 25. U1 Error Status Word**

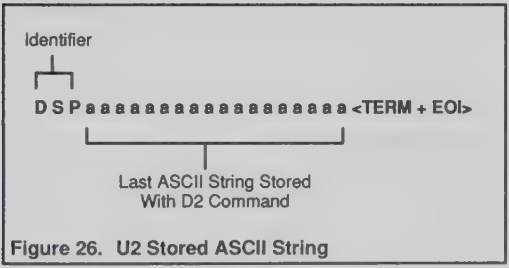



**Figure 26. U2 Stored ASCII String**

MSTG01,0,0K0M000,0N0R1T4,0,0,0V1Y0 <TERM + EOI>

**G — Output Data Format**

Items (sum of bits)
00 = No Items
01 = Source value
02 = Delay value
04 = Measure value
08 = Time value

Format
0 = ASCII, prefix and suffix
1 = ASCII, prefix no suffix
2 = ASCII, no prefix or suffix
3 = HP binary
4 = IBM binary

Lines
0 = One line from dc buffer
1 = One line front sweep buffer
2 = All lines from sweep buffer

**K — EOI and Bus Holf-off**

0 = Enable EOI and hold-off
1 = Disable EOI, enable hold-off
2 = Enable EOI, disable hold-off
3 = Disable EOI and hold-off

**M — SRQ Mask and Compliance Select**

Mask (sum of bits)
000 = Mask cleared
001 = Warning
002 = Sweep done
004 = Trigger out
008 = Reading done
016 = Ready for trigger
032 = Error
128 = Compliance

Compliance
0 = Delay, measure, or idle compliance
1 = Measurement compliance

**N — Operate**

0 = Standby
1 = Operate

**R — Trigger Control**

0 = Disable triggering
1 = Enable triggering

**Figure 27. U3 Machine Status Word (Factory Default Conditions Shown)**

IDENTIFIER



MSTG01,0,0K0M000,0N0R1T4,0,0,0V1Y0 <TERM + EOI>

**T — Trigger Configuration**

Origin
0 = IEEE X
1 = IEEE GET
2 = IEEE talk
3 = External (TRIGGER IN pulse)
4 = Immediate trigger only

Trigger In
0 = Continuous
1 = ^SRC DLY MSR
2 = SRC^DLY MSR
3 = ^SRC^DLY MSR
4 = SRC DLY^MSR
5 = ^SRC DLY^MSR
6 = SRC^DLY^MSR
7 = ^SRC^DLY^MSR
8 = ^Single Pulse

Trigger Out
0 = None
1 = SRC^DLY MSR
2 = SRC DLY^MSR
3 = SRC^DLY^MSR
4 = SRC DLY MSR^
5 = SRC^DLY MSR^
6 = SRC DLY^MSR^
7 = SRC^DLY^MSR^
8 = Pulse End^

Sweep End^ Trigger Out
0 = Disabled
1 = Enabled

**V — 1100V Range Control**

0 = 1100V Range Disabled
1 = 1100V Range Enabled
(237 only)

**Y = Terminator**

0 = <CR><LF>
1 = <LF><CR>
2 = <CR>
3 = <LF>
4 = none

**U3 Machine Status (Factory Default Conditions Shown) (Cont.)**

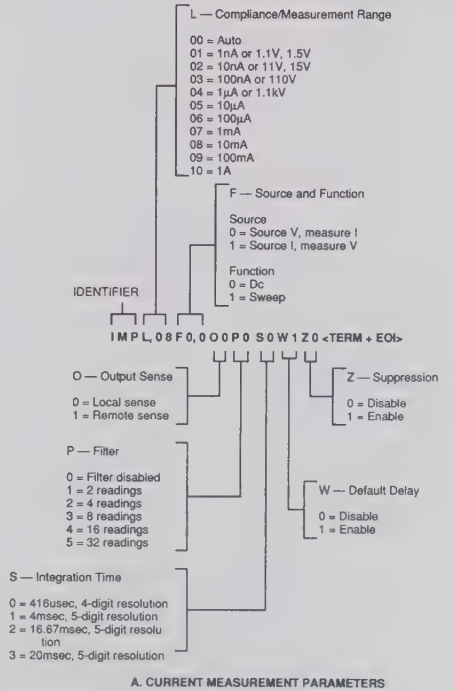
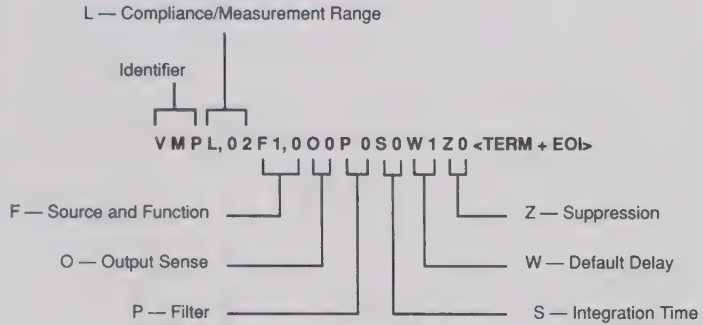
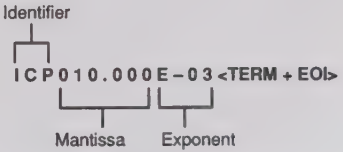


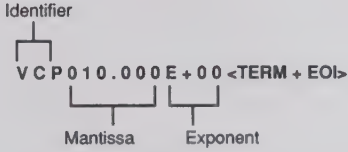

**Figure 28. U4 Measurement Parameters (Factory Default Conditions Shown)**




**B. Voltage Measurement Parameters**
**(see Figure 28A for parameter descriptions)**

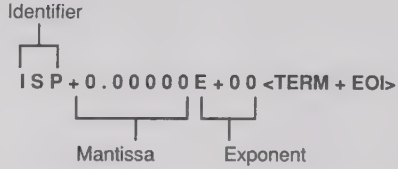



**A. Compliance Value for Current Measurements**

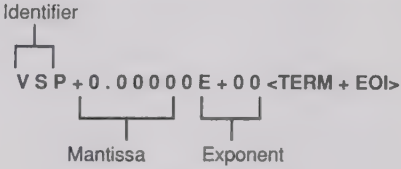



**B. Compliance Value for Voltage Measurements**

**Figure 29. U5 Compliance Value (Factory Default Conditions Shown)**




**A. Suppression Value for Current Measurements**




**B. Suppression Value for Voltage Measurements**

**Figure 30. U6 Suppression Value (Factory Default Conditions Shown)**

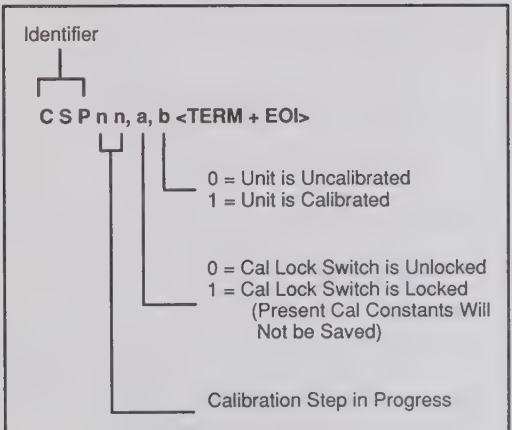

Identifier
C S P n n, a, b <TERM + EOI>
0 = Unit is Uncalibrated
1 = Unit is Calibrated
0 = Cal Lock Switch is Unlocked
1 = Cal Lock Switch is Locked
(Present Cal Constants Will
Not be Saved)
Calibration Step in Progress

**Figure 31. U7 Calibration Status Word**

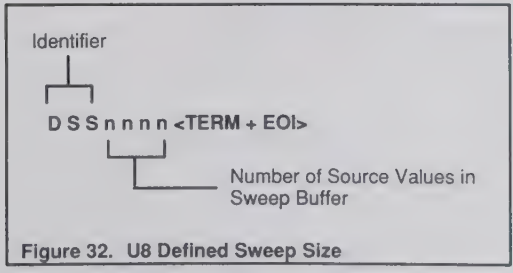
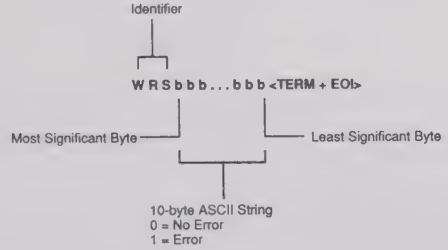



**Figure 32. U8 Defined Sweep Size**

Figure 33. U9 Warning Status Word




| | |
|---|---|
| **Most Significant Byte** | Uncalibrated |
| | Temporary Cal |
| | Value Out of Range |
| | Sweep Buffer Filled |
| | No Sweep Points, Must Create Sweep Points |
| | Pulse Times Not Met |
| | Not In Remote |
| | Measure Range Changed Due to 1kV/100mA or 110V/1A Range Select |
| | Measurement Overflow (OFLO)/Sweep Aborted |
| **Least Significant Byte** | Pending Trigger |

Figure 34. U10 First Sweep Point in Compliance

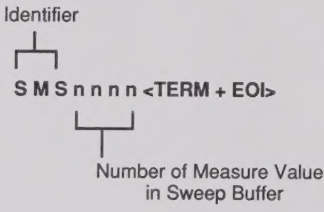



**Figure 35. U11 Sweep Measure Size**

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